SIDEREAL, SYNODIC, AND ANOMALISRIC LUNAR PERIODS

(Lunar Periods for Phase, Orbit, and Distance)

Introduction: Examine the PowerPoint on lunar phases found near slide 40, here. It shows the moon progressing through a 99-day and a 110-day sequence of phases, librations, and distances. From these slides and YouTube videos found in the same section, you will be able to gain a better appreciation for the:

1. **Phase Period of the Moon:** This is called the synodic period, the interval of time it takes the moon to complete a full series of phases, important for the month, how early humans established calendars, the prediction of eclipses, and the saros (repetition) cycle.
2. **Orbital Period of the Moon around the Earth:** This is termed the sidereal period and it is determined by the moon's passage across a reference position in the sky, such as the First Point of Aries, the location where the sun crosses the equator signaling the beginning of spring.
3. **Perigee to Perigee and Apogee to Apogee Periods of the Moon:** Called the anomalistic month, it is the time it takes the moon to travel from closest to closest positions to the Earth (perigee to perigee) and farthest to farthest positions from the Earth (apogee to apogee).

Procedure for Determining the Synodic (phase) Period of the Moon:

1. **The major phases of the moon**—New Moon, First Quarter, Full Moon, and Last Quarter are shown near page 34, here.
2. **The 99 and 110-slide PowerPoint sequences will allow you to determine the day** of the New Moon, First Quarter, Full Moon, and Last Quarter moons. The day counts are indicated in the upper left of each slide. They start near slide 40, here.
3. **Proceed through all of the slides in the Misconceptions PowerPoint**, listing the days when these phases occurred.
4. **Where there is a diagonal arrow, repeat the same day count of the phase at the top of the arrow**.
5. **State the interval of time between the repetition of like major phases, as well as the average length of time for each phase type in the right column.** Keep in mind that each picture shows the moon's phase at 12:01 a.m. Note that the phase series composed of 99 slides was completed near Earth's aphelion (farthest position from the sun), while the second series of 110 slides was completed near Earth's perihelion (Earth's closest location to the sun).
6. **Add the results of the right column and divide by the number of rows** where data was collected (5) to find an average of the averages. Your calculation will be placed in the lowest box to the right.

Additional Recommendations: Watch the class video, Phases of the Moon Demonstrated, then complete the exercise, Know the Moon's Phases in the "Misconceptions" chapter. Submit this to your instructor for a grade. Take the lunar phase practice quiz found near slide 14 in the Lecture Slides. Know the phase that comes before and after the one pictured in the sample quiz.

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PHASE PERIOD OF THE MOON

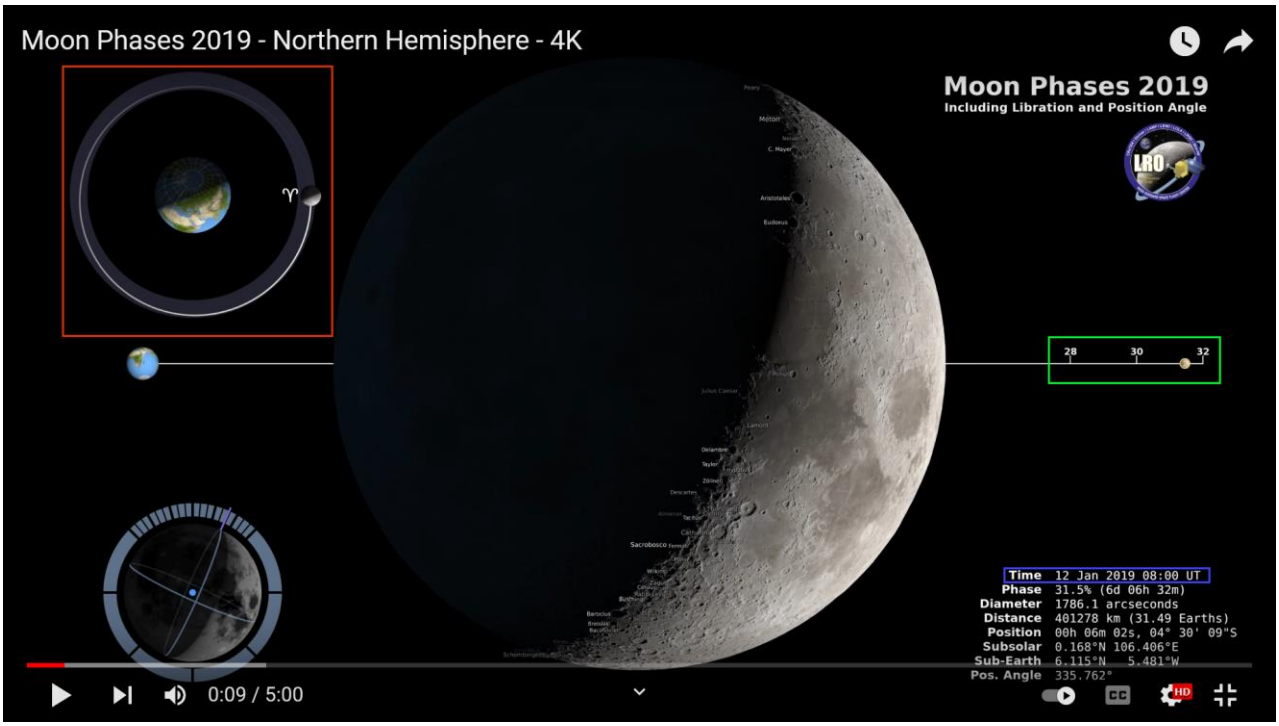
This phase series was completed near aphelion, when Earth's orbital speed was slowest.

Lunar Phase **Completed near Earth Aphelion (Earth farthest from the sun)**	**Day**	**Days Between Similar Phases**	**Day** **Arrow: move same number from top to bottom.**	**Days Between Similar Phases**	**Day** **Arrow: move same number from top to bottom.**	**Average No. of Days Between Similar Phases**
New Moon	7					
First Quarter						
Full Moon						
Last Quarter						
New Moon						
Average of All Averages	XXX XXX	XXXXXXX XXXXXXX	XXX XXX	XXXXXXX XXXXXXX	XXX XXX	

This phase series was completed near perihelion, when Earth's orbital speed was at its greatest.

Lunar Phase **Completed near Earth Perihelion (Earth closest to the sun)**	**Day**	**Days Between Similar Phases**	**Day** **Arrow: move same number from top to bottom.**	**Days Between Similar Phases**	**Day** **Arrow: move same number from top to bottom.**	**Average No. of Days Between Similar Phases**
New Moon						
First Quarter						
Full Moon						
Last Quarter	135					
New Moon						
Average of All Averages	XXX XXX	XXXXXXX XXXXXXX	XXX XXX	XXXXXXX XXXXXXX	XXX XXX	

Orbital (Sidereal) Period of the Moon: In this exercise, we are going to use NASA's ***L**unar **R**econnaissance **O**rbiter* data to determine the revolution (orbital) period of the moon around the Earth. You can find the necessary YouTube videos of LRO data here. Use the LRO video for 2019. In the picture below, the red box (upper left) marks the orbital period of the moon. Luna is next to the first point of Aries ♈, the location of the sun on the first day of spring (Vernal Equinox). That will serve as your reference position for determining how long it takes the moon to orbit the Earth. Stop the video when the moon is at the First Point of Aries and note only the day of this passage. That day count is in the lower-right corner of the video, as shown in the blue rectangle. Start in January and complete all of the passages of the moon past the First Point of Aries for that year. Find the number of days between each passage and take the average of those days for each row, placing the number in the far right column. Record in the last column (right, bottom), the average of all the averages for that column.



1. **Here are the number of days each month contains:** J-31, F-28 (**29 in 2024 2028, 2032, 2036, and 2040**), M-31, A-30, M-31, J-30, J-31, A-31, S-30, O-31, N-30, D-31
2. **Arithmetic:** What is the day count between April 4 and May 27? Find the difference between the remaining days in April by subtracting 4 from 30 then adding the number of days in May, 30 – 4 = 26 + 27 = 53. There are 53 days between April 4 and May 27.

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PERIOD OF REVOLUTION OF THE MOON AROUND EARTH

♈	Day	Difference in Days	Day	Difference in Days	Day	Difference in Days	Day	Average In Days
Passing the First Point of Aries ♈	**Jan.**		**Feb.**		**Mar.**		**Apr.**	
Passing the First Point of Aries ♈	**Apr.**		**May**		**Jun.**		**Jul.**	
Passing the First Point of Aries ♈	**Jul.**		**Aug.**		**Sept.**		**Oct.**	
Passing the First Point of Aries ♈	**Oct.**		**Nov.**		**Dec.**	XXXX XXXX	XXXX XXXX	
Average	XXX	XXXX	XXX	XXXX	XXX	XXXX	XXXX	

Procedure for Calculating the Anomalistic Period of the Moon:

The moon orbits the Earth in an elliptical path, getting closer to and farther from Earth. The time it takes the moon to orbit from its closest position, perigee, to the next perigee, or from its farthest location, apogee, to the next apogee, is an interval termed the anomalistic period. The anomalistic interval is important for predicting similar solar eclipses, related to saros cycles.

1. **Watch one of the *Lunar Reconnaissance Orbiter videos,*** you will see the changing angular diameter (size) of the moon in the sky, a function of the moon's changing distance from the Earth.
2. **Go here and use one of the compilations created by NASA's Lunar Reconnaissance Orbiter.** You will get the most accurate results if you incorporate the time difference between events, including the fraction of a day between perigees (the largest moon) and apogees (the smallest moon). **Your instructor will tell you whether you should aim for better accuracy or simply record a day count.**
3. **Note in the table when the moon will be at perigee and apogee.** You can accomplish this by observing the movement of the small ball located to the right of the moon, marked by the green rectangle in the picture found on the previous page. The ball will move between the numbers 28 and 32. Those numbers represent the moon's distance given in Earth diameters.
4. **You can also observe in the video the moon's angular diameter** changing in seconds of arc. Locate the datum two lines below the blue box. The larger the number, the closer the moon is to Earth. Seconds of arc in a circle equals 1,296,000.
5. **Calculate the days** between perigee and the next perigee and apogee to apogee.
6. **Take the average of your findings** to discover the perigee-to-perigee and apogee-to-apogee intervals. Place these in the right column. Finally, take the average of all periods and place your answer at the bottom right of the table.
7. **Hints:** If using the slide sets, maximize your screen brightness. You can slow down the video and increase the image resolution in the settings section. Observe the ball moving back and forth (center right of your screen—green rectangle) or the changing angular diameter of the moon (below the blue box).

8. **Here are the number of days each month contains:** J-31, F-28 (29 in 2028, 2032, 2036, and 2040), M-31, A-30, M-31, J-30, J-31, A-31, S-30, O-31, N-30, D-31
9. **Arithmetic:** What is the number of days between July 27 and August 23? Find the difference between the remaining days in July by subtracting 27 from 31, then add the number of days in August. 31 – 27 = 4 + 23 = 27. There are 27 days between July 27 and August 23.
   Use this method if your teacher asks you to include the day plus hour counts.
10. **Arithmetic:** Find the difference in time between May 15, 05 hours, and June 10, 17 hours. May has 31 days, which is the same as saying **30 days, 24 hours**.
    May 30, 24 hours – May 15, 05 hours = 15 days, 19 hours + June 10, 17 hours = 25 days, 36 hours = 26 days, 12 hours, or 26 days + 12/24 day = 26.5 days.
11. **Decimalize the day in the DIFFERENCE Columns to the nearest 1/10 of a day:** As an example, the final difference between two perigee positions comes to 28-14/24 days, the 14/24 is equivalent to 0.58 day, which would round up to 0.6 day or 28.6 days for your final answer. Divide 24 by 14 (14/24) to get this fraction, then round up or down.

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ANOMALISTIC PERIOD OF THE MOON

(day count or days plus hours decimalized)

	Day/Hr.	Difference Days/Hr.	Day/Hr.	Difference	Day/Hr.	Difference Days/Hr.	Day/Hr.	Average Days/Hr
Perigee Moon Largest	**Jan.** hours	Decimalize Days		Decimalize Days	**Mar.** hours	Decimalize Days	**Apr.** hour	
	Apr. hours	Decimalize Days	**May** hours	Decimalize Days	**Jun.** hours	Decimalize Days	**Jul.** hour	
	Jul. hours	Decimalize Days	**Aug.** hours	Decimalize Days	**Sept.** hours	Decimalize Days	**Oct.** hour	
	Oct. hours	Decimalize Days	**Nov.** hours	Decimalize Days	**Dec.** hours	XXXX XXXX	XXXX XXXX	
Apogee Moon Smallest	**Jan.** hours	Decimalize Days	**Feb**. hours	Decimalize Days	**Mar.** hours	Decimalize Days	**Apr.** hours	
	Apr. hours	Decimalize Days	**May** hours	Decimalize Days	**Jun.** hours	Decimalize Days	**Jul.** hours	
	Jul. hours	Decimalize Days	**Aug.** hours	Decimalize Days	**Sept.** hours	Decimalize Days	**Oct.** hours	
	Oct. hours	Decimalize Days	**Nov.** hours	Decimalize Days	**Dec.** hours	XXXX XXXX	XXXX XXXX	
Average	XXX	XXXX	XXX	XXXX	XXX	XXXX	XXXX	

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